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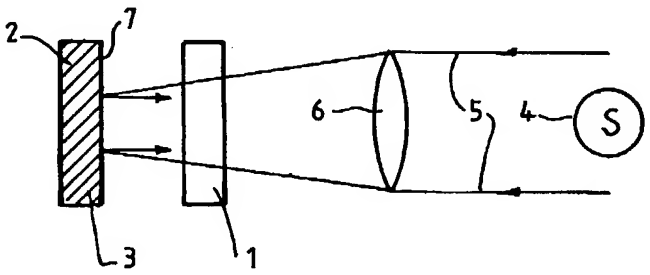
(54) Title: LASER IMPLANTED SECURITY DEVICE



(57) Abstract

A method for embedding a security device into a security document, the security document including a target polymer film (1), the method including laser irradiating a polymer carrier film (2) doped with dopant molecules (3) according to a predefined security pattern with an intensity sufficient to eject the dopant molecules (13) into the target polymer film (1) but below that which causes ablation of a polymer carrier film (12).

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LASER IMPLANTED SECURITY DEVICE

The present invention relates to a method of incorporating a security device into a security document, and in particular to such a method where the security document includes a polymer film. The present invention is suitable for use in polymer based banknotes and it will be convenient to describe the invention in relation to this application. It should be appreciated, however, that the invention is not restricted to use in this application only.

Security documents, such as banknotes, credit cards, bank cards, cash cards, cheques and the like are used in a wide variety of financial transactions. These security documents generally include printed information identifying the security document, such as the denomination of a banknote, as well as various markings, patterns or other optically or electromagnetically variable devices. It is important that these features be incorporated into the security document in such a way as to render the security document difficult to counterfeit.

Visible patterns and designs are often printed in ink on the surface of a banknote, whilst other security devices, such as optically or magnetically variable devices, may be embossed or stamped into the substrate of the banknote. Whilst many of these security features have proved adequate in preventing the unauthorised reproduction of banknotes and other security documents, the increasing sophistication of would be counterfeiters results in an ongoing need to further develop techniques for including security devices in banknotes.

With this in mind, the present invention provides a method for embedding a security device into a security document, the security document including a target polymer film, the method including laser irradiating a polymer carrier film doped with dopant molecules according to a predefined security pattern with an intensity sufficient to eject the dopant molecules and implant said dopant moleculesinto the target polymer film but below that which causes ablation of a polymer carrier film.

The surface of the target film may be rendered more receptive to the implanting of the dopant molecules by firstly softening the surface of the target film.

The dopant molecules may be visible colouring agents, such as dyes, inks or pigments. Alternatively, the dopant molecules may be formed of materials exhibiting differing visual properties from the target polymer film, such as materials having a different refractive index, or materials which are fluorescent , pearlescent, irridiscent or otherwise visually different. The dopant molecules may also exhibit different electromagnetic characteristics from that of the target polymer film, such as magnetic particles.

In one embodiment of the invention, laser beams of different energy levels may be used to implant dopant molecules at a plurality of depths within the target polymer film.

In a first embodiment, the target polymer film may be positioned between a laser source and the polymer carrier film, the dopant molecules being ejected into the target polymer film back towards the laser source. The target polymer film may be at least partially transparent.

In a second embodiment, the polymer carrier film may be positioned between the laser source and the target polymer film, the dopant molecules being ejected from the carrier film away from the laser source. In this instance the target polymer film may be at least partially opaque.

A focusing lens may be used to focus the laser beam onto the polymer carrier film. A mask may also be placed in the path of the laser beam according to the desired predefined security pattern which is to be ejected from the polymer carrier film.

In a further embodiment, two or more laser sources may be used simultaneously on the polymer carrier film, the two or more resultant laser beams interacting to produce an interference pattern. Accordingly, an interference pattern may be established resulting in the transfer of a periodic structure from the polymer carrier film into the target polymer film.

In a preferred application of the invention, the security document may be a banknote whilst the polymer target layer may be a polymer film forming the basis of a substrate used in the production of the banknote.

The following description refers in more detail to the various features of the method for embedding a security device into a security document of the present invention. To facilitate an understanding of the invention, reference is made in the description to the accompanying drawings where the method is illustrated in a preferred embodiment. It is to be understood that the embedding method of the present invention is not limited to the preferred embodiment as illustrated in the accompanying drawings.

In the drawings:

Figures 1 and 2 show the use of a laser beam to transfer dopant molecules from a polymer carrier film into a target polymer film of a security document according to the present invention;

Figures 3 and 4 show a second embodiment of the embedding method according to the present invention;

Figures 5 and 6 show a third embodiment of the embedding method according to the present invention; and

Figures 7 and 8 show a fourth embodiment of the embedding method according to the present invention.

The present invention is particularly, but not exclusively, applicable to banknotes or other security documents having at least a portion of the document formed from a plastics substrate having at least one opacifying layer of ink on one or both of its surfaces. The plastics substrate is preferably formed of a polymeric material, such as PE, PP or PET which may be made up of at least one biaxially oriented polymer film. The substrate may comprise a single layer film of polymeric material. Alternatively, the substrate may comprise a laminate of two or more layers of transparent biaxially oriented polymeric film.

The opacifying layers of printed matter may comprise one or more of a variety of opacifying inks which can be used in the printing of banknotes or other security documents. For example, the layers of opacifying ink may comprise pigmented coatings comprising a pigment, such as titanium dioxide, dispersed within a binder or carrier of cross-linkable polymeric material.

The present invention is based upon the discovery that a laser beam can be used to cause the transfer an ink, pigment, dye or other security device from a first polymer carrier film into the plastics substrate of a banknote or other security document in a controlled manner such that a high resolution embedded image results.

Laser ablation of polymers was first described in the early 1980's. Early reports of laser ablation referred to the clean etching of polymers by focusing the output from high energy, pulsed, UV lasers onto a polymeric surface. The photophysical processes underlying this phenomenon are yet to be completely understood, however the experimentally observed effects are known. As the high energy photons from the laser are absorbed by the sample, the following events occur: the chemical bonds linking the polymeric material are broken, and a shock wave is generated which ejects the polymer fragments explosively from the surface of the polymer. In most cases the fragments are ejected at supersonic speeds.

Use has been made of this technique in the applicant's co-pending International Patent Application No. WO 98/36913, filed 19 February 1998, entitled "Laser Marking Of Articles". In this document, there is described an ablation process applicable to a security document comprising a transparent polymer substrate and printed ink matter on one or both sides. A laser source emits a continuous beam of laser light that causes localised heat build up in the printed ink layer due to the absorption of radiation. The internal bonds and cohesive forces of the layer structure are weakened by the laser beam, and break down, leading to the ablation of the printed ink material from the region at which the laser beam impinges. The transparent polymeric substrate is unaffected by the laser beam, which passes therethrough without causing localised heat build up and ablation. In this way, transparent "windows" may be formed through the banknote.

Surprisingly, it has been discovered that dye and other molecules can be ejected from a carrier film and implanted into a target film by use of an incident laser beam on the carrier film, without the energy of the laser beam causing fragmentation of the dye molecules. It has thus been found possible to embed a security device into a security document by irradiating a polymer carrier film, doped

with dopant molecules, with a laser beam which impinges the surface of the carrier film in a predefined security pattern. The intensity of the laser beam must be sufficient to cause the ejection of the dopant molecules into the target polymer film, but less than the intensity required to cause ablation of the polymeric carrier film itself. The exact value of these intensity levels will vary, depending upon the nature of the polymeric material used, the type of laser source and the dopant molecules borne by the polymeric carrier film.

Turning now to Figure 1, there is schematically shown a polymeric film 1 intended to be used as a substrate in a polymer film based banknote. The polymer film 1 is preferably formed of a transparent polymeric material, in order to absorb as little as possible of the energy from the laser beam passing therethrough.

A polymer carrier film 2 is disposed laterally adjacent the target polymer film 1. The polymer carrier film may be made from polymethacrylate (PMMA), polyethylmethacrylate (PEMA), polybutylmethacrylate (PBMA) or like polymeric material. The carrier film 2 is doped with molecules 3 which are desired to be implanted into the polymer film 1 as a security device in the banknote. Any of a variety of dopant molecules may be used to dope the carrier film. Examples of such molecules are anthracene and pyrene, although a wide variety of other materials may be used.

A laser source 4 is used to generate a laser beam 5, which is focused by a lens 6 to a point at or under the facing surface 7 of the polymer carrier film 2. The laser source 4 may be a XeF Excimer laser source. The intensity of the laser beam 5 is controlled to be less than the threshold at which ablation of the polymeric material forming the carrier film 2 occurs. In such conditions, those dopant molecules within the polymer carrier film 2 which are impinged upon and absorb energy from the laser beam 5 are ejected, without the destruction of the chemical bonds holding the molecules together, from the polymer carrier film 2 towards and into the target polymer film 1. Since fragmentation of the dye molecules does not occur in this process, the dopant molecules now implanted into the target polymer film 1 form a pattern 8 corresponding to the pattern of the laser beam 5 striking the surface 7 of the polymer carrier film 2.

By using a patterned laser beam, dopant molecules are therefore implanted into the polymeric substrate of a banknote or other security document and have a disposition corresponding to that pattern. Fine patterns and markings are able to be formed within the target substrate, and are not simply printed on the surface thereof as was previously possible.

As seen in Figure 3, the laser source 4, polymeric carrier film 2 and target polymer film 1 may be oriented so that the carrier film 2 is positioned between the laser source 4 and the polymer film 1. In this case, the laser beam 5 is focused by the lens 6 onto or under (in this case) the far surface 7 of the carrier film 2, and dopant molecules ejected into the target polymer film 1 away from the laser source 4. The polymer carrier film 2 may be printed or mounted on a transparent carrier film 8. Once again, controlling the intensity of the laser beam 5 to a level less than the threshold at which ablation of the material forming the polymer carrier film will occur, results in the ejection of dopant molecules 10 into the target polymer film 1. In this example, as the laser beam 5 does not pass through the target polymer film 1 prior to ejection of the dopant molecules from the carrier film, the target polymer film may be opaque.

In order that a desired pattern of dopant molecules may easily be formed in the polymeric target film, a mask 11 (see Figure 5) may be interposed between the laser beam 5 and the polymeric carrier film 2. The opening 12 of the mask 11 may be shaped in any desired pattern, so that only those dopant molecules 13 upon which the patterned laser beam is incident, are ejected.

In a more sophisticated arrangement shown in Figures 7 and 8, two or more laser sources 20, 21 may be used to produce corresponding laser beams 22 and 23, which are both directed to the same area of the carrier film 2. The interference of the two laser beams 22 and 23 results in the intensity of the laser beam within the polymeric carrier film having a periodic variability. Accordingly, the depth at which the dopant molecules within the carrier film 2 will be excited and ejected therefrom will periodically vary. This results in the ejection and implantation into the target film 1 of a periodic three dimensional structure 24. By use of appropriate

optically variable material, three dimensional security devices, such as moyer gratings, etc., may be thus created and implanted within the banknote substrate.

It is to be understood that various modifications and/or additions may be made to the method for embedding a security device into a security document without departing from the ambit of the present invention.

CLAIMS:

1. A method for embedding a security device into a security document, the security document including a target polymer film, the method including laser irradiating a polymer carrier filmed doped with dopant molecules according to a predefined security pattern with and intensity sufficient to eject the dopant molecules and implant said dopant molecules into the target polymer film but below that which causes ablation of a polymer carrier film.

2. A method according to claim 1, wherein the surface of the target polymer film is rendered more receptive to the implanting of the dopant molecules by firstly softening said target film surface.

3. A method according to either of claims 1 or 2, wherein the dopant molecules are visible colouring agents, such as dyes, inks or pigments.

4. A method according to either of claims 1 or 2, wherein the dopant molecules are formed of materials exhibiting differing visual properties to the target polymer film.

5. A method according to claim 4, wherein said dopant molecules are formed from materials having a different refractive index to that of the target polymer film.

6. A method according to claim 4, wherein said dopant molecules are fomed from materials which are fluorescent, pearlescent or irridescent.

7. A method according to any one of the preceding claims, wherein said dopant molecules exhibit different electromagnetic characteristics from that of the target polymer film.

8. A method according to claim 7, wherein said dopant molecules are formed from magnetic particles.

9. A method according to any one of the preceding claims, wherein laser beams of different energy levels are used to implant dopant molecules at a plurality of depths within the target polymer film.

10. A method according to any one of the preceding claims, wherein said target polymer film is positioned between a laser source and the polymer carrier film, the dopant molecules being ejected into the target polymer film back towards the laser source.

11. A method according to claim 10, wherein the target polymer film is at least partially transparent.

12. A method according to any one claims 1 to 9, wherein the polymer carrier film is positioned between the laser source and the target polymer film, the dopant molecules being ejected from the carrier film away from the laser source.

13. A method according to claim 12, wherein said target polymer film is at least partially opaque.

14. A method according to any one of the preceding claims, wherein a focusing lens is used to focus the laser beam onto the polymer carrier film.

15. A method according to any one of the preceding claims, wherein a mask is placed in the path of the laser beam according to the desired predefined security pattern which is to be ejected from the polymer carrier film.

16. A method according to any one of the preceding claims, wherein two or more laser sources are used simultaneously on the polymer carrier film, the two or more resultant laser beams interacting to produce an interference pattern.

17. A method according to any one of the preceding claims, wherein the security document consists of a banknote and the polymer target layer comprises a polymer film forming the basis of a substrate used in the production of said banknote.

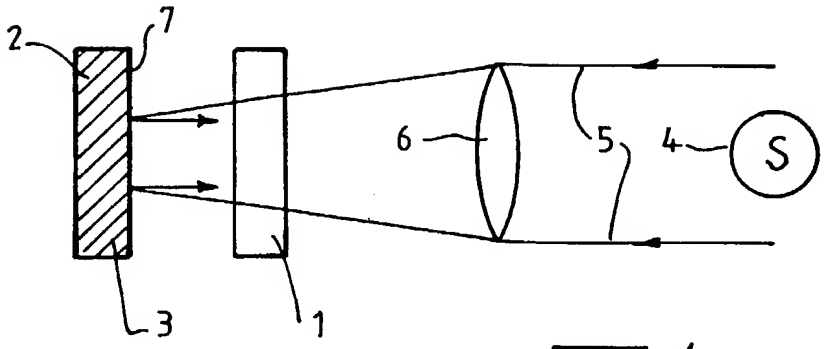

FIG. 1.

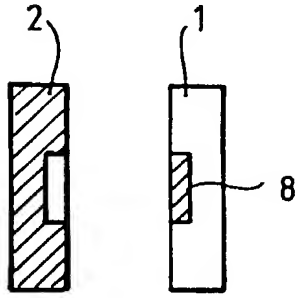

FIG. 2.

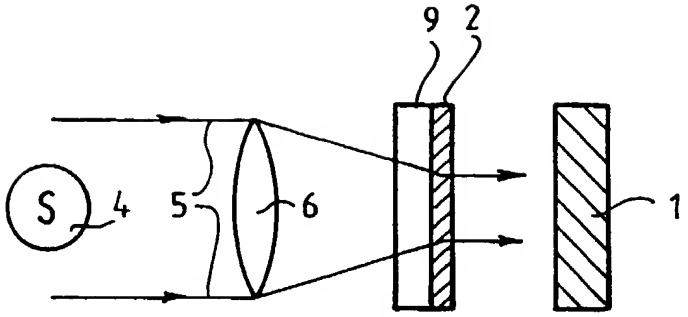

FIG. 3.

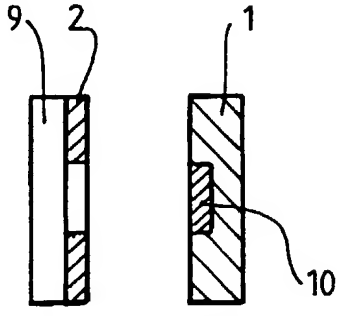

FIG. 4.

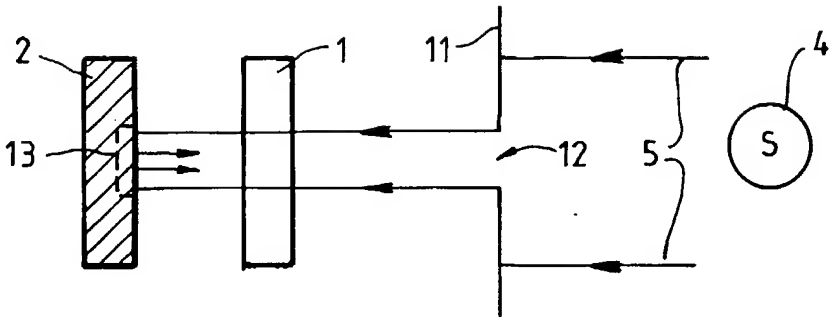

FIG. 5.

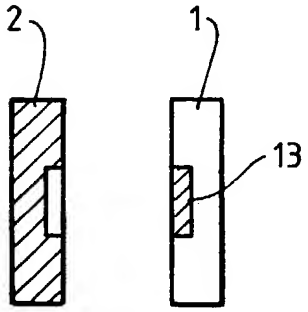

FIG. 6.

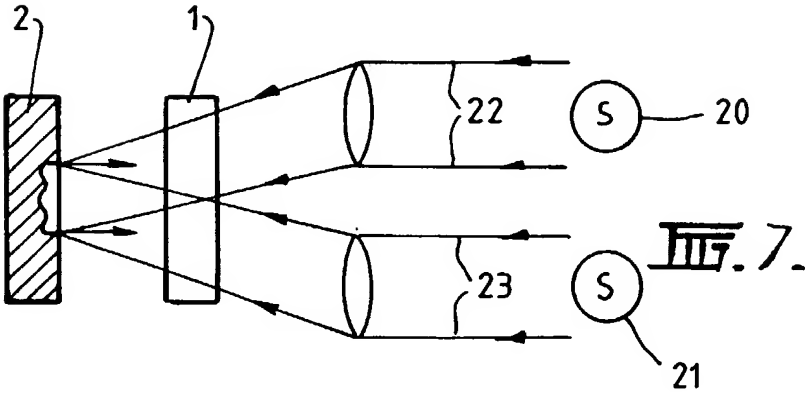

FIG. 7.

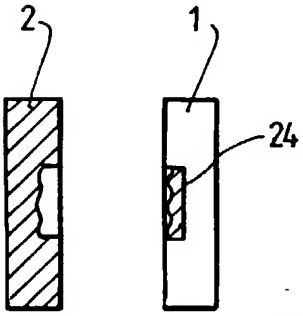

FIG. 8.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: B41J 2/435, B41M 3/14, 5/035

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41J-2/-, 3/-, B41M-3/-, 5/-, B42D 15/-

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97/38864 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 23 October 1997 whole document, especially page 10 lines 12 ff	1,3-8,10-15,17
X	US 4804977 A (LONG) 14 February 1989 whole document, especially column 2 line 64 to column 3 line 7	1,3-8,12-15,17
X	WO 96/32662 A (IMPERIAL CHEMICAL INDUSTRIES PLC) 17 October 1996 whole document	1,3-8,10,11,15,17

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/AU	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95/30545 A (IMPERIAL CHEMICAL INDUSTRIES PLC) 16 November 1995 whole document	1,3-8,10-14, 15,17
X	Derwent Abstract Accession No 98-351953/31, Class A89, G06 JP 10-133394 A (SHOWA DENKO KK) 22 May 1998 abstract	1,3-8,10-17
A	Derwent Abstract Accession No 98-392651/34, Class A97, E21, G05 JP 10-157315 A (TOPPAN PRINTING CO LTD) 16 June 1998 abstract	1-17

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00373

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Patent Document Cited in Search Report		Patent Family Member			
WO	97/38864	US	5693446		
US	4804977	WO	89/09980		
WO	96/32662	GB	9507485		
WO	95/30545	EP	758297	GB	9408904
JP	10-133394	NIL			
JP	10-157315	NIL			

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